Determining the Percentage Composition.

Over 300 years ago chemists defined the Law of Constant Composition. It states that the composition of a compound is a fixed ratio by mass of the elements in the compound. The Law of Constant Composition is the basis for determining the percentage composition of a compound. The percentage composition is the percentage by mass of each element present in a compound.

To calculate a percentage composition we start with the chemical formula. We then determine the mass of each element in 1 mole of the compound as well as the total mass. Then we calculate the percentage of the total mass for each element.

Example #1: Calculate the percentage composition of water.

Solution:

Assume there is 1 mol of water

water = H_2O

$m_H = 2\,mol\,(M_H) = 2\,mol\,(1.01\,g/mol) = 2.02\,g\ H$

$m_O = 1\,mol\,(M_O) = 1\,mol\,(16.00\,g/mol) = 16.00\,g\ O$

$m_{H_2O} = M_H + M_O = 2.02\,g + 16.00\,g = 18.02\,g.$

$\%\,H = \frac{2.02\,g}{18.02\,g} \times 100\% = 11.2\,\%$

$\%\,O = \frac{16.00\,g}{18.02\,g} \times 100\% = 88.8\%$

∴ the percentage composition is 11.2% hydrogen and 88.8% Oxygen.

Example #2: Determine the percentage composition of sodium carbonate, Na_2CO_3.

Solution: Assume there is 1 mole of Na_2CO_3.

$m_{Na} = 2\,mol(M_{Na}) = 2\,mol(22.99\ g/mol) = 45.98\ g$

$m_C = 1\,mol(M_C) = 1\,mol(12.01\ g/mol) = 12.01\ g$

$m_H = 3\,mol(M_O) = 3\,mol.(16.00\ g/mol) = 48.00\ g$

$m_{Na_2CO_3} = 45.98\ g + 12.01\ g + 48.00\ g = 105.99\ g$

$\%\,Na = \frac{45.98\ g}{105.99\ g} \times 100\% = 43.4\%$

$\%\,C = \frac{12.0\ g}{105.99\ g} \times 100\% = 11.3\%.$

$\%\,O = \frac{48.00\ g}{105.99\ g} \times 100\% = 45.3\%.$

∴ The percentage composition is 43.4% Na, 11.3% C and 45.3% O.

P119 #7.